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RESEARCH ARTICLE



The syndemic of COVID-19 and methanol poisoning in Mashhad, Iran

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ABSTRACT

Background: At the beginning of the COVID-19 epidemic in Iran, ethanol shortages and the false belief that drinking alcohol could prevent infection led to a sharp increase in homemade alcohol consumption. Consequently, on some days, hospitalizations due to toxic alcohol poisoning exceeded those related to COVID-19.

Objective: To describe the epidemiology, clinical characteristics, ocular and neurological sequelae, management, and outcomes of acute methanol poisoning during the early COVID-19 surge in Mashhad, Iran.

Methods: This cross-sectional study enrolled all individuals with acute methanol poisoning who received standard care. We recorded demographics, medical history, exposure type, time from ingestion to symptoms, initial presentation, methanol levels, acidosis, treatments, outcomes, and COVID-19 status.

Results: A total of 208 patients with acute methanol poisoning were studied. Most consumed homemade alcohol and presented 24–72 h after ingestion. Forty-four drank alcohol to prevent COVID-19. During hospitalization, 108 developed visual impairment; 45 became permanently blind, and 32 died despite treatment.

Conclusions: The rapid spread of COVID-19 initially triggered an outbreak of methanol poisoning in Iran. Despite treatment, 87 patients (42%) died or developed permanent complications, and mortality remains high due to delayed hospital admission and diagnosis.

List of abbreviations: COVID-19: Coronavirus Disease 2019; ECG: Electrocardiogram; BE: base excess.

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KEYWORDS

COVID-19; methanol; poisoning; optic neuropathy; patients

Background

Methanol, also known as wood alcohol or methyl alcohol, is a colorless alcohol that smells and tastes like ethanol. It is mainly used as an organic solvent in varnishes, antifreeze solutions, fuel, and paint (Pressman et al., 2020). Methanol poisoning could be accidental or the result of a suicide attempt. However, in Iran, in most cases, the consumption of illegally produced ethanol leads to methanol poisoning (Aghababaeian et al., 2019).

Methanol's toxicity results from its metabolite, formic acid, which accumulates and induces metabolic acidosis and cytochrome oxidase inhibition in mitochondria, leading to histotoxic hypoxia (Hantson, 2006). The visual pathway and brain are particularly vulnerable to formic acid. However, other organs can also be severely affected depending on the severity of metabolic acidosis (Kaewput et al., 2021).

Clinical effects appear after a latent period of 6–30 h (or longer if the patient has also consumed ethanol). The common clinical presentations of methanol poisoning are vertigo, headache, abdominal pain, vomiting, and nausea; however, studies demonstrated that these symptoms could also appear in late stages. In later stages, drowsiness can quickly progress to obtundation, respiratory arrest, and coma

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(Nekoukar et al., 2021). Vision loss is painless and usually develops in both eyes within one to three days; vision may recover or deteriorate subsequently over the following weeks (Sanaei-Zadeh et al., 2011). Diplopia, blurred vision, reduced visual acuity, visual field restriction, photophobia, and transient or permanent blindness are manifestations of visual impairments. In 20–40% of patients who survive acute poisoning, permanent visual loss has been observed (Ashurst & Nappe, 2018).

As a result of these serious complications, prompt diagnosis and aggressive treatment are required for methanol poisoning. To quickly correct acidosis, sodium bicarbonate is used, and ethanol is used to inhibit the metabolism of toxic substances (Zakharov et al., 2015). The last choice of treatment is hemodialysis, which considerably improves the chance of survival while simultaneously reducing the risk of ocular damage (Hassanian-Moghaddam et al., 2019). During the COVID-19 pandemic in Iran, most of the available ethanol was used to clean surfaces. On the other hand, it was widely believed that consuming alcohol would disinfect the mouth and body and prevent infection by eliminating viruses. Therefore, the frequency of methanol poisoning increased significantly, resulting in a new crisis (Delirrad & Mohammadi, 2020).

As a result of that, acute methanol poisoning has become a serious public health problem during the COVID-19 pandemic. Furthermore, it has resulted in numerous complications and mortality, and this study was designed to evaluate the epidemiology, clinical characteristics, management, and complications of this methanol poisoning outbreak.

Methods

Study design and population

This cross-sectional study with a prospective data-collection approach was conducted on all patients with acute methanol poisoning from February 2020 to May 2020 (the early COVID-19 period) in the Toxicology Department of Imam Reza Hospital, affiliated with Mashhad University of Medical Sciences, Mashhad, Iran. All patients received the necessary treatments, including ethanol, bicarbonate, and folic acid. For patients with visual impairment, adjunctive therapy with methylprednisolone and erythropoietin was administered in addition to the standard treatment regimen. The rationale for this approach is based on its positive impact on visual outcomes, as reported by several previous studies (Feizi et al., 2024; Pakravan et al., 2016; Yinski & Nusanti, 2019). Furthermore, if indicated, the patients underwent hemodialysis. Fomepizole and ethanol are both antidotes for methanol poisoning. Fomepizole inhibits the alcohol dehydrogenase enzyme, while ethanol competes with methanol for the same enzyme (Mégarbane, 2010). Ethanol can be used as an alternative antidote in regions where fomepizole is not available. During hospitalization, patients who tested positive for COVID-19 were transferred to the intensive care unit and received appropriate treatment.

Evidence has supported the therapeutic effects of these two drugs in methanol-induced optic neuropathy.

Methods

A checklist was used to record demographic information, past medical history, exposure type (accidental or intentional), previous history of addiction, the time between ingestion and onset of symptoms, initial clinical presentation, methanol levels, acidosis, treatments, and the patient's outcome. In addition, data were collected using patient medical records, including patient history, laboratory tests, and counseling related to patients' neurological and ocular manifestations. Due to the prevalence of COVID-19 infection during this study, all patients with acute respiratory syndrome were evaluated paraclinically to separate them from other patients. In addition, patients with visual impairment have been assessed by one ophthalmologist during hospitalization and one month after discharge.

Data analysis

Statistical analyses were conducted on 208 consecutive eligible cases using IBM SPSS Statistics, v16.0 (Chicago, IL, USA). Because of the absence of a single primary outcome with a predefined effect size,

no formal sample size calculation was performed. Post hoc power assessments indicated sufficient power for key outcomes (mortality and major visual impairment), with caution for possible Type I/II errors and adjustments for multiple testing during interpretation analyses.

We presented descriptive data as means with standard deviations for normally distributed continuous variables and medians with interquartile range (IQR) for non-normally distributed continuous variables. Categorical variables were reported as frequencies and percentages.

Continuous variables were analyzed as follows: two-group differences were explored using the independent t-test, and three-group comparisons were performed via one-way ANOVA, with nonparametric alternatives employed when distributional assumptions were not satisfied. Categorical associations were evaluated with chi-square tests, with Fisher's exact test as appropriate. Relationships among continuous variables were quantified with Pearson correlation coefficients. Furthermore, binary logistic regression models were used to identify predictors of two distinct outcomes (complications and mortality). Predictor effects are presented as odds ratios (ORs) with 95% confidence intervals (CIs) and *p*-values. In all analyses, statistical significance was set at a two-sided *p*-value of < 0.05.

Ethical consideration

Written informed consent was obtained from patients. In patients with impaired levels of consciousness, informed consent was obtained from the patient's legal guardian. Moreover, the study protocol was fully approved by the Ethics Committee of Mashhad University of Medical Sciences (IR.MUMS.MEDICAL.REC.1399.338).

Results

Two hundred and eight patients suffering from acute methanol poisoning were enrolled in the study. Table 1 presents the baseline attributes of these patients, comprising 181 males and 27 females with an average age of 29.6 years. The majority of patients (96.6%) had consumed homemade alcohol and presented themselves 24 to 72 h after ingestion (56.7%). Moreover, a total of forty-four patients (21.2%) had consumed alcohol as a protection against COVID-19 infection. Figure 1 demonstrates a flowchart of the included patients and their eventual outcomes.

Table 1. General information on methanol poisoning patients.

Variables		Mean $\pm$ SD or N (%)
Age		29.6 $\pm$ 9.1
Gender	Male	181 (87)
	Female	27 (13)
Living area	Urban	161 (77.4)
	Rural	44 (22.6)
Job	Self-employment	117 (56.3)
	Employee	22 (10.6)
	Housekeeper	14 (6.7)
	Manual worker	13 (6.3)
	Student	26 (12.5)
	Collegian	6 (2.9)
	Unemployed	7 (3.4)
	Home-made	201 (96.6)
Alcohol type	Industrial	4 (1.9)
	Opium	16 (7.7)
Substance abuse history	Tramadol	1 (0.5)
	Marijuana	1 (0.5)
	Crystal	3 (1.4)
	Negative history	187 (89.9)
Time from ingestion to presentation (hours)	<4	3 (1.4)
	4–11.9	12 (5.8)
	12–23.9	61 (29.4)
	24–71.9	118 (56.7)
	>72	11 (5.3)
For preventing COVID-19 infection?	Yes	44 (21.2)
	No	161 (77.4)

Abbreviations: SD: standard deviation, N: number.

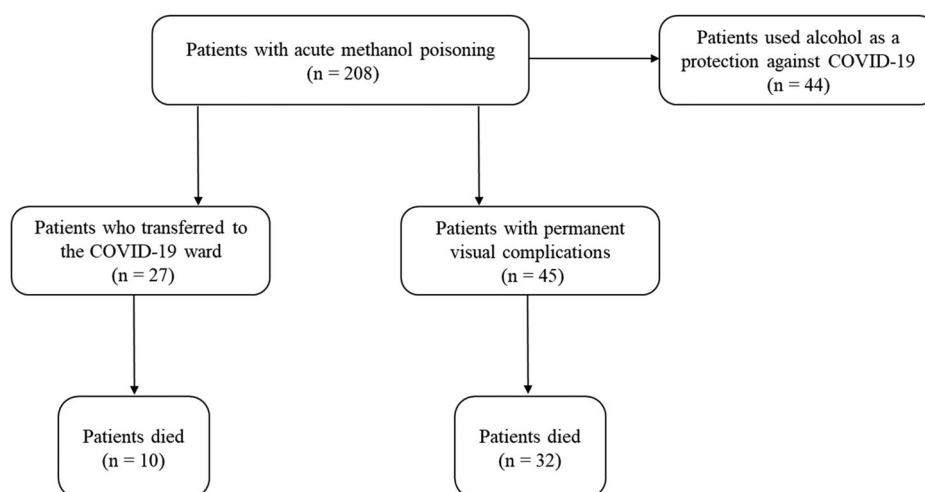


Figure 1. Flow chart of the included patients.

Table 2. Vital signs and laboratory data of patients on admission.

Variables		Mean $\pm$ SD
Respiratory rate (breaths/min)		18.9 $\pm$ 2.7
Temperature ($^{\circ}$ C)		37.1 $\pm$ 0.2
Pulse rate (beats/min)		89.5 $\pm$ 12.6
Blood pressure (mmHg)	Systolic	120.2 $\pm$ 14.3
	Diastolic	78.8 $\pm$ 10.7
	MAP	93.1 $\pm$ 9.8
Arterial blood gas	PH	7.2 $\pm$ 0.2
	PCO ₂ (mmHg)	34.9 $\pm$ 14.5
	HCO ₃ ⁻ (mmol/L)	14.1 $\pm$ 7.8
	BE	-13.7 $\pm$ 10.2
Blood sugar (mmol/l)		7.40 $\pm$ 3.80
Serum sodium (mmol/l)		139.7 $\pm$ 4.5
Serum potassium (mmol/l)		4.4 $\pm$ 1.1
Urea (mmol/l)		2.78 $\pm$ 1.46
Creatinine (μ mol/l)		88.8 $\pm$ 53.0

Abbreviations: SD: standard deviation, MAP: Mean arterial pressure, PCO₂: partial pressure of carbon dioxide, HCO₃⁻: bicarbonate, BE: base excess.

Table 2 presents the vital signs and laboratory findings of patients upon admission. The mean arterial blood pH of patients at admission was 7.2 ± 0.2 , with 39% of patients ($n=78$) suffering from severe metabolic acidosis ($pH < 7.15$). Additionally, 10.3% of patients ($n=16$) had a blood sugar level exceeding 200 mg/dL.

In terms of clinical presentation, the majority of patients experienced nausea (67.3%), followed by confusion (33.2%), headache (28.8%), vertigo (27.4%), and weakness (21.2%). Also, the most common change in ECG was tachycardia (Table 3).

One hundred and eight patients reported one visual impairment, twenty-four reported two, seven reported three, and one reported four. The types of visual impairments on admission are presented in Figure 2.

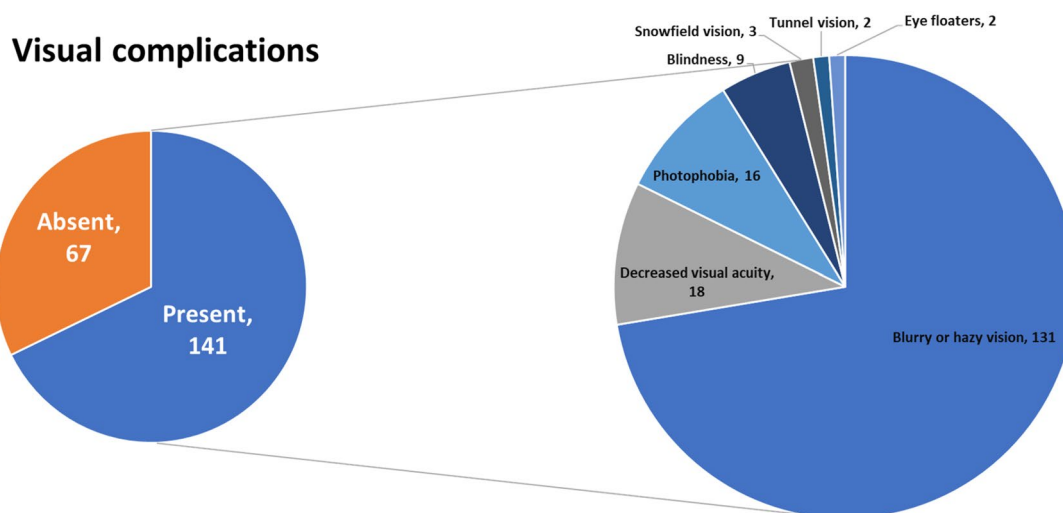
Twenty-seven patients were transferred to the COVID-19 ward due to respiratory symptoms and positive tests, among whom ten died. Additionally, 45 patients (21.6%) suffered from permanent visual complications, and 32 patients (15.4%) died. Based on Table 4, patients with complications exhibited a higher mean age ($p=0.014$). It is worth mentioning that the average age of deceased patients was significantly greater ($p=0.025$), and the time to hospital was considerably shorter ($p=0.013$).

Also, arterial blood gas analysis revealed that patients who survived with complications or died had significantly lower levels of pH, HCO₃⁻, and BE (base excess) ($p=0.0001$). Although hyperglycemia had no significant association with the incidence of complications ($p=0.482$), it was associated with a considerable increase in mortality rate ($p=0.001$). The amount and type of alcohol consumed and consumption for COVID-19 prevention were not significantly different between the two groups. Patients who presented with coma and convulsions experienced lasting complications and passed away ($p=0.001$ and 0.005 , respectively).

Table 3. Clinical presentation and ECG changes of patients.

Variables		Frequency (%)
Clinical manifestations	Abdominal pain	58 (27.9)
	Nausea	140 (67.3)
	Headache	60 (28.8)
	Vertigo	57 (27.4)
	Weakness	44 (21.2)
	Dyspnea	28 (13.5)
	Seizure	9 (4.3)
	Confusion	69 (33.2)
	Coma	11 (5.3)
	Visual impairment	141 (67.8)
ECG changes	Short PR	0 (0)
	Long QTC	0 (0)
	Bradycardia	2 (1)
	Tachycardia	42 (20.2)
	Arrhythmia	5 (2.4)

Abbreviations: ECG: electrocardiogram, PR: PR interval, QTC: QT interval corrected for heart rate.

**Figure 2.** The frequency of visual complications.**Table 4.** The relationship between demographic and clinical factors in patients who survived complications or deceased.

Variables		Complications		p-value	Death		p-value
		Yes	No		Yes	No	
Age		32.4 ± 8.9	28.2 ± 9.2	0.014 ¹	32.9 ± 10.9	28.9 ± 8.7	0.025 ¹
Gender	Male	38 (34.5)	72 (65.5)	0.02 ²	29 (16)	152 (84)	0.7 ²
	Female	7 (50)	7 (50)		3 (11.1)	24 (88.9)	
Arterial blood gas	PH	7.1 ± 0.2	7.2 ± 0.1	0.016 ¹	6.9 ± 0.2	7.2 ± 0.1	0.0001 ¹
	PCO ₂	31.3 ± 14.5	34.6 ± 12.2	0.18 ¹	38.3 ± 18.2	34.3 ± 13.7	0.17 ¹
	HCO ₃	12.2 ± 7.3	15.1 ± 7.2	0.03 ¹	7.6 ± 4.5	15.2 ± 7.8	0.0001 ¹
	BE	-15.4 ± 7.9	-11.1 ± 9.2	0.01 ¹	-25.2 ± 7.1	-11.6 ± 9.2	0.0001 ¹
Hyperglycemia*		11 (22)	39 (78)	0.482 ²	23 (46)	27 (54)	0.001 ²
The amount of ingested alcohol (ml)		428.9 ± 259.6	392.0 ± 374.3	0.5 ¹	478.3 ± 340.1	366.4 ± 296.7	0.06 ¹
Alcohol type	Homemade	43 (36.1)	76 (63.9)	0.84 ²	31 (15.4)	170 (84.6)	0.13 ²
	Industrial	2 (50)	2 (50)		0 (0)	4 (100)	
Serum Methanol level (mg/dl)		48.5 ± 33.3	35.0 ± 35.7	0.044 ¹	53.1 ± 37.8	39.4 ± 39.0	0.073 ¹
Coma	Yes	0 (0)	2 (100)	0.534 ²	9 (81.8)	2 (18.2)	0.001 ²
	No	45 (36.9)	77 (63.1)		23 (11.7)	173 (88.3)	
Seizure	Yes	1 (25)	3 (75)	0.99 ²	5 (55.6)	4 (44.4)	0.005 ²
	No	44 (36.7)	76 (79)		27 (13.6)	171 (86.4)	
Time from ingestion to presentation (hours)		32.5 ± 18.2	30.2 ± 16.8	0.485 ¹	21.9 ± 12.4	28.5 ± 17.3	0.013 ¹
Refer to the COVID-19 ward	Yes	6 (22.2)	21 (77.8)	0.937 ²	10 (37)	17 (63)	0.003 ²
	No	39 (21.5)	142 (78.5)		22 (12.2)	159 (87.8)	

Abbreviations: PCO₂: partial pressure of carbon dioxide, HCO₃: bicarbonate, BE: base excess. *Blood sugar level ≥140mg/dl. Analyses were performed using the ¹individual t-test or ²chi-square test.

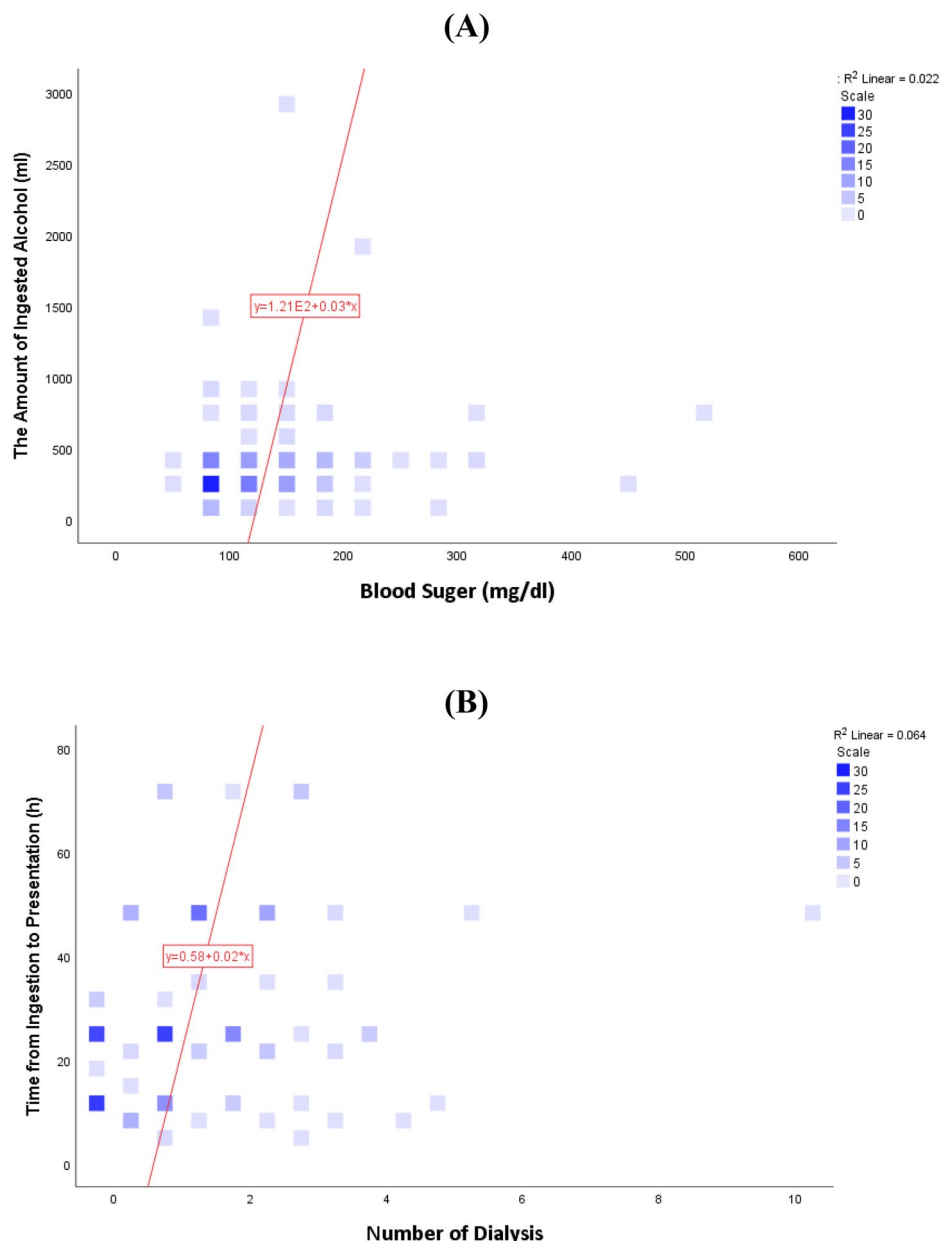


Figure 3. The correlations between (A) the amount of ingested alcohol and blood sugar and (B) time from ingestion to presentation and the number of dialysis.

The mean serum methanol level was 41.5 ± 39.0 mg/dl (median = 31.3, IQR = 6.6 - 65.8). As Table 4 shows, patients with complications had statistically significantly higher blood levels of methanol ($p=0.044$), while this pattern was not observed in deceased patients ($p=0.073$).

When investigating the relationship between alcohol consumption and blood sugar levels, it was found that there was an increase in blood sugar with higher alcohol ingestion. However, this correlation did not reach statistical significance (Pearson's correlation: 0.14, $p=0.069$). On the other hand, a statistically significant correlation was observed between the time from ingestion to presentation and the number of necessary dialyses. Specifically, a longer time interval between ingestion and presentation was associated with a greater number of dialyses required (Pearson's correlation: 0.25, $p=0.0001$) (Figure 3).

To identify key factors independently associated with complications and mortality, binary logistic regression analyses were performed (Table 5). For complications, age was associated with lower odds (OR 0.93; 95% CI 0.88–0.98; $p=0.012$), while other covariates showed non-significant associations after adjustment (e.g., blood sugar, alcohol type, serum methanol, etc.). For mortality, no covariate reached statistical significance ($p>0.05$).

Table 5. Multivariable predictors of complications and mortality.

Predictor	Complications		Death	
	Or (95% CI)	p-value	Or (95% CI)	p-value
Age	0.93 (0.88–0.98)	0.012	1.02 (0.88–1.18)	0.806
Gender	0.23 (0.05–0.98)	0.048	0.07 (0.00–2.00)	0.122
Blood sugar	1.01 (0.99–1.03)	0.168	0.99 (0.97–1.03)	0.893
The amount of ingested alcohol	0.99 (0.99–1.00)	0.272	0.99 (0.99–1.00)	0.691
Alcohol type	0.55 (0.21–1.48)	0.241	1.94 (0.34–11.13)	0.459
Serum Methanol level	0.99 (0.98–1.00)	0.157	1.00 (0.97–1.04)	0.687
Refer to the COVID-19 ward	1.12 (0.31–4.08)	0.867	6.47 (0.87–48.13)	0.068

Analyses were performed using binary logistic regression.

Discussion

In our study, 208 patients with methanol poisoning were examined; most of the patients were male (87%) with an average age of 29.6 ± 9.1 years and lived in urban areas. We investigated the epidemiology, clinical characteristics, and outcomes of patients with acute methanol poisoning during the COVID-19 pandemic. Importantly, our study demonstrates the rate of visual impairment caused by methanol poisoning (67.8%) and the risk factors related to mortality (seizures, coma, and metabolic acidosis), and the rate of mortality caused by it (14.5%). In Iran, national laws prohibit the consumption of alcoholic beverages. This has led to the production and consumption of homemade, illegal, and non-standard alcoholic beverages, which can cause acute methanol poisoning. At the beginning of the COVID-19 pandemic, there was a belief that drinking alcoholic beverages could prevent infection by killing the virus. However, this is not supported by scientific evidence and is therefore not recommended as a preventive measure (Delirrad & Mohammadi, 2020).

The most common clinical manifestation in the patients at the time of visit was nausea (67.3%), followed by headache (28%) and abdominal pain (27%). These findings were similar to the results of the study by Eghbali et al. in Tehran (Eghbali et al., 2015). In this study, patients were predominantly male (82.1%), and the most common clinical symptom was nausea (37.5%). Consistent with our findings, nausea was the most common clinical manifestation (70.6%) in patients enrolled in Masoumi et al.'s study. Similarly, 84.3% of their patients were male and lived in urban areas. (Massoumi et al., 2012).

According to the study results, clinical symptoms manifested in the majority of patients approximately 24 h after methanol ingestion. This finding is consistent with Shadnia et al.'s study, which reported a similar onset time for clinical symptoms (Shadnia et al., 2013). The delayed onset may be attributed to the fact that methanol is not toxic in its original form and must be metabolized into harmful substances such as formate. Methanol is converted to formaldehyde by alcohol dehydrogenase, which is then converted to formic acid by formaldehyde dehydrogenase. The breakdown of formic acid into water and carbon dioxide is a time-consuming process. Clinical manifestations of methanol poisoning occur after a latent period, as this is a time-consuming process (Liu et al., 1998).

The study findings suggest a positive correlation between alcohol consumption and blood sugar levels. However, this association was not statistically significant. Blood sugar ($BS \geq 140$) was significantly associated with mortality ($p=0.001$), but not the incidence of complications ($p=0.482$). Also, in Sanae et al.'s study, hyperglycemia (sugar above 140) was reported as a prognostic factor and a risk factor for death (Sanaei-Zadeh et al., 2011). Further studies are necessary to investigate the relationship between blood sugar levels and mortality as well as complications. The precise cause of hyperglycemia is unknown; however, methanol intoxication has been linked to severe pancreatitis, which might be a factor in the development of hyperglycemia. Increasing counter-regulatory hormones as a result of the acute stress of methanol intoxication might also be a contributing factor (Kajbaf et al., 2007).

The prevalence of visual impairment caused by methanol poisoning in our study was reported as 67.8%. The most common injuries were blurred vision, decreased visual acuity, and photophobia. The prevalence of visual impairment in this study is almost identical to that found by Sanaizadeh et al. (55.7%) (Sanaei-Zadeh et al., 2011). In a 2019 study conducted in Shiraz by Rokn Abadi et al., the prevalence of visual impairment was reported to be 75%. The most common types were blurred vision (40%) and blindness (35%) (Mousavi Roknabadi et al., 2021). In Fazel Rabbi's study, conducted in Bangladesh from 2008 to 2014, 104 patients with methanol poisoning were examined. The study reported blurred

vision as the most common visual disorder, with a prevalence of 20% for visual impairment. In this study, the most common clinical symptom was gastrointestinal symptoms, including nausea, vomiting, and abdominal pain. These results are similar to those of our study (Chowdhury et al., 2014). In a separate work conducted in the United States by Wisit et al., 603 patients diagnosed with methanol poisoning were examined (Kaewput et al., 2021). The study reported a prevalence of visual impairment at 8%. The difference in the incidence of visual impairment between our country and other nations is significant.

The study found that the most common ECG manifestation in patients was sinus tachycardia (20.2%). An investigation by Nikoo et al. in Shiraz, Iran, which examined 356 cases of methanol poisoning for ECG changes, found that the most common manifestations were J-point elevation (70.6%), U wave (61.3%), and early repolarization (Nikoo et al., 2020). Additionally, another study from the United Kingdom found that the most prevalent findings were sinus tachycardia and non-specific T-wave changes (Jaff et al., 2014). Additional research is necessary to examine electrocardiogram (ECG) alterations in cases of methanol poisoning.

Our study found that coma, seizures, and metabolic acidosis were risk factors associated with mortality. Additionally, we observed that higher levels of methanol were correlated with an increased risk of complications. The factors associated with mortality in various studies are nearly identical. The study conducted by Chen Yee Lee in China evaluated 32 patients with methanol poisoning and found that coma and impaired consciousness were significant risk factors for mortality. Other risk factors associated with mortality in this study included hypothermia and elevated serum creatinine levels (Lee et al., 2014). Wisit et al. found that respiratory failure, kidney failure, and neurological disorders (such as seizures and loss of consciousness) were factors related to death (Kaewput et al., 2021). The study conducted by Kute et al. found that mortality was related to acidosis, coma, and seizures ($p < 0.001$), which is consistent with our findings (Kute et al., 2012).

Despite improvements in management, methanol poisoning still has a significant mortality rate. Based on the results of this study, the death rate due to acute methanol poisoning in the studied population was 14.5%. In the study of Yousefinejad et al., a mortality rate of 15% was reported in Sanandaj, Iran, which is similar to our findings (Yousefinejad et al., 2020). In other studies, conducted in different parts of Iran, the mortality rate is almost double that of our investigation. For example, we can refer to the work by Sanaei-Zadeh in Tehran (Sanaei-Zadeh et al., 2011) and Shadnia in Tehran (Shadnia et al., 2013), where the mortality rate was reported as 28% and 30%, respectively.

Studies conducted in other parts of the world report a significantly lower mortality rate. For instance, Ghanoum's study in the United States (Ghannoum et al., 2014) reported a mortality rate of 2.9%. Access to better medical care could be one of the reasons for the lower mortality rate in these countries. For example, patients were treated with fomepizole as an antidote. But fomepizole is not available in our country, and ethanol is used as an antidote. The unavailability of fomepizole may be a significant factor contributing to the rise in mortality rates in our country.

Dangerous methanol poisoning can be prevented by more careful planning and monitoring of illegally distributed homemade alcohol. On the other hand, the importation of fomepizole or the production of fomepizole (the main antidote to methanol) by Iranian pharmacologists may be effective in reducing patient mortality.

Strengths and limitations

One strength of this study is its comprehensive examination of a significant number of patients with methanol poisoning, including their complications and mortality over time. One limitation of the study is that the mortality rate may have been affected by the coexistence of COVID-19 and methanol poisoning in some patients. Specifically, 27 patients were transferred to the coronavirus ward, and 10 patients died. It is possible that the complications of poisoning alone did not justify the death of this number of patients.

Conclusions

The outburst and rapid spread of COVID-19 created a simultaneous epidemic of methanol poisoning. Moonshine incorporates a considerable amount of methanol, resulting in substantial complications and mortality in our patients. The majority of patients affected were male individuals aged between 20 and

40 years. Visual impairments, nausea, confusion, headache, and vertigo were the most prevalent clinical indications. Blurry and hazy vision were the most commonly reported visual impairments, whereas tunnel vision was the least frequent. The time between methanol ingestion and presentation, as well as the amount consumed, may be critical factors in the onset of methanol poisoning complications and mortality.

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Authors' contributions

CRedit: **Seyed Reza Mousavi**: Writing – review & editing, Supervision; **Parastoo Zareh**: Data curation; **Farah Pouramiri**: Supervision, Writing – original draft; **Naser Shoeibi**: Data curation; **Mohammad Mojahedi**: Data curation; **Majid Khadem-Rezaian**: Formal analysis; **Seyed Amirhossein Mousavi**: Writing – review & editing, Supervision; **Sadaf Sadat Rafati**: Writing – review & editing.

Disclosure statement

The authors have no competing interests to declare.

Ethics approval and consent to participate

All stages of the study followed the ethical principles of Helsinki and were approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran (IR.MUMS.MEDICAL.REC.1399.338). Patients filled out a written informed consent before participating in the study. Also, no additional costs have been imposed on patients for this study, and patients have been studied during their treatment-diagnostic process.

Consent for publication

Written informed consent was obtained from all of the patients.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

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